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ADDRESSES DELIVERED AT THE OPENING OF THE NEW SOCIETY HOUSE, NOVEMBER 24TH, 1897.

DEDICATORY PRAYER...RT. REV. H. C. POTTER.
ADDRESS.....PRESIDENT B. M. HARROD.
ADDRESS.....GEN. WM. P. CRAIGHILL.
ADDRESS..... J. G. SCHURMAN, LL.D.
ADDRESS.....HON. JOSEPH H. CHOATE.
RESOLUTIONS ADOPTED.

DEDICATORY PRAYER, BY RT. REV. H. C. POTTER.

Let us pray. Almighty and Everlasting God, who art always most ready to hear our petitions and art wont to give to us more than we can desire or deserve, we thank thee that thou hast taught us in thy holy Word to come to thee and to ask thy heavenly benediction upon all our human undertakings. We are here this afternoon to ask thy blessing upon this work, upon the crown of success which thou hast vouchsafed us to put upon it, and to beseech thee to take it into thy holy keeping and to make it useful for those great ends for which this institution stands. We bless thee for the revelation of thy law, as in Nature, so in thy holy Word. We bless thee that thou hast taught

us how the forces of Nature may be harnessed by the ingenuity of man and made to do the service of man. We thank thee for the triumphs of this union in all the history of the century in which we live, so various in its illuminating and transforming powers, so wonderful in its manifold illustrations of the word of thy revealed scriptures that "many shall run to and fro and that knowledge shall be increased," over the highways which have been built by the art of men, in which wisdom and light have gone all around the world and that the representatives of this institution, and those who are like-minded, have carried to the ends of the world that which has come from the lamp of the student and from the patient, constant and vigilant study and experiment of men who have discovered and settled the laws by which so largely to-day our great natural forces are harnessed and governed for the purposes of man. Grant, we pray thee, that the wonderful wisdom as thus wrought in thy universe may continue to work under thy divine and supervising guidance, and that all men everywhere to whom thou hast given the faculties of ingenuity, of contrivance, of study, the art of penetrating the secrets of thy Word, may be glad to use them in thy fear and to thy glory. We give this institution to-day and all who belong to it into thy holy keeping. We ask thy blessing upon its officers and upon all present, and we beseech thee that everyone here may recognize that in what he does for art, for science, for the upbuilding of material structures, he is thy servant in the use of thy divine forces to the glory of thy holy name. Remember our common country and all who rule over us. Remember all men everywhere who are striving out of the chaos of ignorance and waywardness and lawlessness to bring mind and heart and man into subjection to the higher law, and so finally to service to thee. And all this we ask in the name and for the sake of Him who has taught us when we pray to say: "Our Father, who art in heaven, hallowed be thy Name. Thy kingdom come. Thy will be done on earth, as it is in heaven. Give us this day our daily bread. And forgive us our trespasses, as we forgive those who trespass against us. And lead us not into temptation; but deliver us from evil: for thine is the kingdom, and the power, and the glory, forever and ever. Amen.

ADDRESS OF B. M. HARROD,

PRESIDENT, AM. SOC. C. E.

Ladies and Gentlemen,—I thank you, in behalf of the American Society of Civil Engineers, for the lustre and dignity which your presence gives to the dedication of this House, to the promotion of that learning and the encouragement of that professional and fraternal fellowship which are necessary to the growth and influence of the science of civil engineering.

Our intention in erecting this commodious building has not been limited to serving the close uses of a club, or even to providing a professional resort for our own members. We have been moved by larger aims, and have builded with the hope that we might greatly aid in promoting those objects of a National Society, and in supplying those wants of our profession which have been made prominent and important by the extent and direction of its evolution during the present generation.

The discovery of new forces in Nature, and the invention of new methods of their application to the uses of man, have so enlarged the field of civil engineering that neither the duration of human life nor the limit of human faculties serves for the acquisition of such a knowledge of the details of all of its branches as is sufficient to insure success in the practice of each or all of them. This condition and limitation of modern scientific learning has become so controlling that it is now necessary to prepare special courses of study, to confer special degrees, to form special social and professional organizations, and to establish a special press for the mechanical, the sanitary, the electrical, and other classes of civil engineers. Also the rapid expansion of our country, and the marvelous diversity of its topographical features, have in many cases and localities limited the practice of engineers to work in a single department, such as the improvement of rivers and harbors, municipal engineering, the extraction of ores and minerals, the irrigation of lands, and their protection from overflow. These tendencies, with the great intervening distances, involving time and expense, have made the opportunities of resort to a single center so infrequent and difficult, that the reasonable social and professional wants of the civil engineer have inevitably led to the formation of special or local societies.

The variation from which this evolution of the technical society has sprung is both natural and useful, and has contributed largely to the promotion of scientific learning, the efficiency of the profession, and the success of its members.

But while we recognize the obligations of the profession to the agencies to which I have alluded. the conviction still remains that they have not sufficed to bring its members into that social and professional fellowship which is the evidence of healthy growth, and the outward and visible sign of the unity of the scientific knowledge on which the best practice is based, and of the singleness of our ultimate aims; nor has their success been sufficient to give our profession a position in the public estimation, as both learned and responsible, the peer of law or medicine, to which it is entitled by the contributions it has made to the public wealth, happiness and safety, and which has been accorded to it in countries where the motives of specialization and the difficulties of general and personal association are not so controlling as they are here. Certainly the record of American civil engineering, in difficulty, in magnitude, in originality, in thoroughness, and in the opportunity it has given for the growth of the best civilization, is at least comparable to that of any country or age. Certainly the labors of the civil engineers in this country have contributed a share to its development and prosperity which has not been exceeded by any other class of her citizens.

It is worthy of consideration, whether in the diversity of study and work resulting from modern conditions, we are not losing sight of the essential unity of the profession, and of the truth that, while mining, sanitary, electrical or other lines of engineering may be differentiated in practice by the exigencies of the times, yet there is a science of civil engineering which is not only a remainder after these are taken away, but an organized body of correlated truths forming the roots and trunks of a great tree of knowledge of which these are but the branches. "It is not a mere juxtaposition of parts, but a complex organic whole, and its different departments are so closely allied that, without a general knowledge of all, it is impossible to have a complete comprehension of, or eminent success in, any."

With this view, the birth, the growth of every special or local society, and the expansion of the field of its labors, is but another reason for co-ordination, and the application of their accumulated influence and resources to a common purpose, to the promotion of learn-

ing and the prosperity of our profession, through the agency of a single organization, in which they may all find representation and alliance.

It is fit that this unity and breadth of the science, and the interest of American civil engineering, should find an exponent in a National Society, where all engineering knowledge and all of its departments shall receive adequate consideration; where engineers from all parts of the country can meet for the formation of friendly ties or the exchange of professional views, and where measures for the promotion of the welfare of civil engineers and of civil engineering can be concerted with such full and impartial consideration of all of their aspects as will command national attention and respect.

Among the functions which have been or can be properly exercised by such a society for the increase of the dignity and strength and good-fellowship of the entire profession, I may mention the conventions now annually held in different parts of the country, both the social and professional results of which have been of much interest and value; also the appointment of select special committees for the examination of questions of material or method, concerning which practice is uncertain or unsettled; also the excursion of American Civil Engineers to the Paris Exposition, and other parts of Europe, in 1889; also the reception and entertainment of foreign engineers, the organization of the Engineering Congress and the publication of the *Transactions* of that Congress, on the occasion of the Chicago Exposition in 1893, from which sprung that most useful Society for the promotion of engineering education; also the timely presentation, by memorial and committee, of important subjects of applied science to the attention of Congress; also the publication of transactions by such a society, proportioned in range, in value and volume to its membership; also the collection of a comprehensive library, and the adoption of liberal rules for its use; and, I may add, the building of a House where all these plans may be considered and matured; where all recorded technical knowledge can be safely stored and made available; where civil engineers can meet to form and strengthen the ties which should bind professional brethren together; to seek, by reference or conference, such information as they may need for projected work, and to participate in or otherwise promote the dignity, the welfare and the pleasures of a professional life.

This Society stands for the increase of both general and special scientific culture in civil engineering; for the extension of professional and personal fellowship, based on this general culture, among engineers engaged in any of its various branches, and in all parts of the country; and for such just increase in the standards, the dignity, the rights and the emoluments of the profession as may be expected to follow earnest and intelligent organization and co-operation. This House is dedicated to these uses.

It is not without a serious sense of responsibility that we introduce our Society to this new and enlarged stage of its life. In the past, since its birth in 1852, its growth in members, in resources and in good work, has been so rapid and uninterrupted as to vindicate the *raison d'être* of a National Association of Civil Engineers. It has acquired new strength by the use of its powers. But the anxieties of a new and larger life are on our shoulders, and we invoke and welcome the kind offices and interest of our friends. From our members we ask a vigilant and sustained interest in the objects and administration of the affairs of the Society; from their sweethearts and wives that they will exact a paper from their correlated members, and insist on attending the next Annual Convention; and from civil engineers and the enlightened public a serious consideration of the relation which the Society bears to the welfare of the profession and the progress of our country, and the service which it has already rendered, and can render, in an increasing degree, in the future.

Let me again thank you for the interest and good wishes which are expressed by your presence here to-day, and welcome you to our New Society House.

ADDRESS OF GEN. WILLIAM P. CRAIGHILL,

PAST-PRESIDENT, AM. SOC. C. E.

Mr. President, Ladies and Gentlemen,—I think myself fortunate in having the privilege in this public way to be able to congratulate the American Society of Civil Engineers upon the auspicious event which brings us together to-day, marking, as it does, a great step forward for the Society in material prosperity.

It has been suggested that it would be appropriate for me to speak from the standpoint of the military engineer. This I therefore do, and, following the very proper intimation contained in the invitation extended to me by the Committee of Arrangements, I will be brief.

What I shall say will be in the direction of indicating the influence upon the profession of civil engineering which has been exerted by the military engineers of this country and the reasons for it. In so doing I must necessarily refer to the Military Academy at West Point, and to the Corps of Engineers of the Army, and I trust to be excused if my words should be warm concerning the Alma Mater who gave me professional birth, and concerning my professional brothers in the Corps of Engineers, all her sons, with whom I have been associated for more than forty-four years in the service of our country.

First, it is true that the properly prepared military engineer must necessarily have also the general education of the civil engineer in the ordinary use of that term. In the structures he builds he is called upon to use all the materials, wood, earth, stone and metals which are found in the works of the civil engineer. The structures of the military engineer are peculiar in their forms and arrangements in order to suit them to their special functions. So far as their foundations and stability are concerned, under the various strains to which they are to be exposed, they must conform to the usual rules for civil works. But they are also liable to sudden and violent shocks from the impact of the huge missiles of modern war, which may strike them with their highest velocities, and special provision must be made to meet these special conditions. Therefore, at the Military Academy at West Point, the education, from its beginning to its close, leads one through text books on pure and applied mathematics, chemistry, mineralogy, draughting, surveying, the laws of civil engineering, and finally the specialty of military engineering.

In the earliest days of our country the engineer of any kind was hard to find. Many people suppose a man to be an engineer who is only a surveyor. An engineer should be conversant with the duties of the surveyor, but a man could be an excellent surveyor all his life and not be an engineer at all. Washington was a surveyor in his youth, and doubtless could have become a great engineer, but an inspection of the site of Fort Necessity, not far from Pittsburg, where he was forced to surrender to the French, would not lead one to conclude that he was well versed at that time in the art of the military engineer. He no doubt did the best that the circumstances permitted, many of which we do not know.

In the campaigns of the Revolutionary War, Washington felt the need of native military engineers, and was obliged to depend on foreigners, mainly Frenchmen. But among them was one distinguished Pole, Kosciusko, to whom a monument stands at this day at West Point, the scene of his labors in the defence of that important post, which Washington himself knew well and where he had his headquarters when the discovery of Arnold's treason occurred.

As early as October, 1776, a committee of the Continental Congress recommended that the Board of War be directed to provide a military academy, and this scheme was highly favored by General Knox, one of the leading military authorities of the time. General Washington never ceased during the war to call the attention of Congress to the importance of a systematic organization of the army and the education of its officers in scientific knowledge and for this reason he urged the establishment of a military academy. This he continued to do from the close of the war in 1783 to the end of his life in 1799.

The law of 1802 created a corps of engineers which, as its words state, "shall constitute a military academy." This law was approved by Jefferson as President, though he alone, when a member of the cabinet of Washington, had doubted in 1793 the constitutionality of a military academy. The academy was located at West Point, a place peculiarly fitted for such an institution.

We have now many most valuable technical schools, and several of them are not surpassed by any similar schools in the world. At these engineering is specially taught much more fully and extensively in all branches, except the military and naval, than is possible at West Point with its peculiar limitations, but the Military Academy at West Point

was the first school of engineering in this country and for a long time the only one. In the excellence of its methods and course of instruction it claims to have been progressive and to be now the equal of any school, so far as thoroughness goes, having in view the special duties to which its graduates are likely to be called.

But the Corps of Engineers of the Army is older than the Military Academy, inasmuch as General Washington was authorized in December, 1776, to raise and collect for six months a corps of engineers; but for want of proper material in the country he could accomplish nothing. On July 8th, 1777, several of the officers of the Royal Corps of French Engineers were commissioned. From the lack of trained engineers in the native continental establishment, their assistance was highly appreciated, and for many years this foreign influence predominated in the service. As late as 1816, a prominent French engineer was employed to assist in planning some of the defensive works of this country. He had served creditably on the staff of the great Napoleon. This was General Bernard. His views are largely exemplified at Fort Monroe, where he planned a kind of fortress somewhat after the European idea to which he was accustomed, but it is a style not in accordance with American ideas or institutions.

On March 11th, 1779, a corps of engineers was formally established, and its first chief was a Frenchman. In 1783, at the close of the war, this corps was disbanded. In 1794, a new organization was formed, including engineers and artillerists, which was modified by later and successive laws, until in 1802 the President was authorized to organize and establish a corps of engineers to constitute a military academy and to be stationed at West Point.

Beside the usual duties of military engineers, which are those of constructing temporary and permanent fortifications, military bridges and siege works, in making military reconnaissances and surveys, the preparation and use of mines and torpedoes in coast defence, etc., they have been called upon in time of peace to plan and execute works of river and harbor improvement, to build lighthouses, plan docks for the Navy, and to undertake and complete many other public works, such as the introduction of water into the City of Washington, the supervision of the construction of public buildings, such as the Washington Monument in Washington, the Capitol, the Post-Office Department, the Interior Department, the Smithsonian Institution, the New

Congressional Library, etc., to execute surveys for the transcontinental and other railways, to lay down boundaries, etc.

It is thus manifest that the military engineers have had a very great variety of duties, and the course of instruction at West Point has been such as would prepare the men as far as possible for the duties imposed upon them. A great number of civilians have been associated with the military engineers in their varied duties. While I held the office of Chief of Engineers, it was found that there were over five thousand men serving in the engineer department all over the United States, in the grades of engineer, surveyor, draughtsman, rodman, chainman, recorder, clerk, superintendent, inspector, overseer, pilot, etc., not including the still greater number of persons hired by contractors.

Many of these employees of the engineer department have become prominent as civil engineers, and much credit is due them for the results of their labors. No one is more anxious than I am to have them receive the credit which is their just due. A number of these men are now Members of this Society. I am sure that very much of any professional reputation I may have is due to the cordial, loyal and able assistance I have had from my subordinates, both in and out of the Corps of Military Engineers.

Many engineer officers have from time to time resigned and become distinguished as civil engineers, as teachers and otherwise. The superintendence of the construction of one of the greatest and earliest railroads in Europe, that between St. Petersburg and Moscow, was, from 1842 to 1849, in charge of Major Whistler, an American engineer.

The writings of some of the officers of the Corps of Engineers were standard authorities in their time ; for example, Wright, Totten and Gillmore, on mortars, limes, cement and concrete; Woodbury, on the arch ; Halleck, on asphalts ; Sanders, on pile-driving ; Mahan, on civil engineering, etc. The extensive use of asphalt and concrete in this country may be said to have originated with the Corps of Engineers on works of fortification. The superintendents and professors of the Military Academy have almost all been taken from the Corps of Engineers.

Here let me introduce some short extracts from the writings of another :

"Up to about 1831, the officers of the Corps of Engineers were to a great degree the repositors in this country of that knowledge which was requisite for the purpose of making accurate surveys. The location and construction of the roads, canals and bridges built for the development of the resources of the country, and the accurate methods of surveying, geodetic, topographic and hydrographic, now in use, are in a great measure due to the talents and labors of its officers.

"Very many of the great routes of internal communication in the interest of commerce and speedy transit, now in existence in the country, were first explored, located and projected by officers of this corps. The files of the bureau of the corps in Washington and the congressional documents are rich in reports upon the works of this character that have been examined into under authority of law by the Corps of Engineers.

"In the matter of improvement of rivers and harbors, in the interest of commerce, the Corps of Engineers has had almost the exclusive control, and the information on this subject contained in the reports of its officers, from the early years of this century to the present time, now filed in the bureau of the corps, is a monument to its labors, and a most valuable collection of precedents to be used in the future prosecution of such works.

"The surveys, examinations and constructions which have been made by officers of the corps, have not been confined to such matters as are solely in charge of the War Department. From time to time the State Department, the Navy Department, the Treasury Department and the Interior Department have employed its officers in the running of boundary lines, and the surveys for the maps necessary to be used in delicate diplomatic negotiations; in the surveys for, and the construction of, dock-yards; the surveys for canal routes across the Isthmus of Panama and elsewhere; upon astronomical observations in the interest of science; in the surveys of the coasts, the planning and construction of lighthouses and other fixed aids to navigation; the planning and construction of public buildings, of custom houses, post offices, marine hospitals, etc.

"Scarcely a branch of engineering, whether military or civil, can be mentioned that has not been improved and expanded by the study and labors of the officers of this corps.

"It is difficult to enumerate all the duties which may have been, or which can be devolved on the Corps of Engineers in time of peace. As the duties generally are such as require familiarity with the sciences and arts, any duty which the Government needs performed which involves the application of this character of learning, and comes within the professional training of the several members of the corps, may by law be devolved by the President upon them."

I think what has been said is a sufficient ground for the belief on my part, and its statement in this presence, that the education and discipline of West Point, supplemented by the methods used in the practice of the officers of the Corps of Engineers of the Army, have had a very great influence upon the profession of engineering in this country, and that influence has been to a very large extent beneficial and creditable.

In conclusion, Mr. President and brother engineers, I affirm that the profession of the engineer is one of the noblest and most useful which is open to man. It is also one of the most ancient. It is a curious historical fact that the title, Pontiff, of the head of the Roman Catholic Church, is derived from *pontifex maximus*, which means the chief bridge builder or engineer; and this was also the title of one of the most important functionaries of Rome long before the rise of the Christian Church, originating with Numa, and held by many of his successors.

I am proud to have been an engineer for nearly half a century, and I am proud now to be a member of this American Society of Civil Engineers. May her ends be always high, noble and honorable, and may membership in our society be always a guarantee of ability, honor and faithfulness in the performance of duty. It has been thought by some that we should have a written code of ethics for our guidance. I do not believe that such a code is necessary, provided we regulate our professional conduct by that rule which is able to cover every possible case between man and man, the Golden Rule, in its true, broad sense: Do to all men as you would have them do to you.

Before taking my seat I beg the indulgence of this body of engineers to refer to something in which every engineer is interested, and the military engineer in particular. It has been said by some that the peculiar duties of engineers in peace unfit them for the successful command of troops in the field. Let me state a few facts about this matter from our own history: When the late Civil War was closed, the Army of the Potomac, that magnificent body of veteran soldiers, was commanded by Meade, an ex-officer of the Corps of Engineers. Every corps in that army except the cavalry was also commanded by an officer of engineers. This was also true of two of the corps in the Army of the James, which co-operated with the Army of the Potomac.

McPherson, who fell at Atlanta, and Mansfield, who fell at Antietam, were two of the earliest brigadiers of the regular army in that war, and both came from the Corps of Engineers.

In two of the most critical and fiercely contested battles of the war, Antietam and Gettysburg, both armies were commanded by ex-officers of the Corps of Engineers; at Antietam, McClellan and Lee; at Gettysburg, Meade and Lee. Rosecranz and Weitzel were also officers of engineers. On the Southern side, among their greatest soldiers were Robert E. Lee, Joseph E. Johnston and Beauregard, all ex-officers of the Corps of Engineers. On both sides were many other engineer officers whose names I could give, such as Newton, Whiting, Ruger, Wilson, MacKenzie, Poe, Abbott, Putnam, O'Rourke, Merrill and others, who were distinguished as soldiers commanding troops. All this could not have come by accident.

ADDRESS OF J. G. SCHURMAN, LL.D.,

PRESIDENT OF CORNELL UNIVERSITY.

Mr. President, Ladies and Gentlemen,—Like the preceding speaker, I received a hint to be brief, and, like him, I shall endeavor to follow the suggestion. But in the few minutes which have been allotted to me I want, at any rate, Mr. President, to convey to you our sincere congratulations on finding you housed in so beautiful a building and in such an excellent location. It is becoming your profession to be progressive. Engineers are always moving forward. I never heard of stationary engineers; or, I never heard of but one, and that was during the Civil War, when Lincoln was anxious that McClellan should move on to Richmond, while the General kept hovering about the banks of the James. Some one called at the White House, and, knowing that McClellan was not in especially high favor just then, ventured, at any rate, to commend him as an engineer. "Yes," said Lincoln, after listening to him, "yes—but a stationary engineer." This Society does not give any evidence of such an attribute. It is true to the requirements of the profession—it is advancing.

Your Society is very closely related, it seems to me, to what is most characteristic of our American civilization. If we go to the old world—if we go to Paris, or to Rome, or to London—we are shown there great collections of art, or memorable buildings, or venerable libraries, in which books and treasures may be found thousands of years old; but when strangers come to our country, we have nothing of that kind to show them. We deplore that art with us is almost in its infancy; that as yet we have produced no poem, no philosophy, no great work of art which will rank with first-class productions of the same kind in the old world. But we show them our bridges, our colossal buildings, our vast systems of railway, our electric lighting and other industrial organizations, and we feel that in these things are embodied the most distinguished achievements of the American spirit. And our greatest men, as General Craighill has indicated to you, have themselves been engineers. Washington, he says, was only a surveyor; but I suppose in those times he might have passed for an engineer, and I often wonder whether the experience which he gathered in West Virginia and on the banks of the Ohio may not have had something to do with

the wonderful skill with which he conducted his marches and countermarches and triumphant retreats.

Well, it is natural for us as Americans, you see, to congratulate the engineers. We know them, we appreciate their works, and we are aware that their achievements are not limited to our own continent. If we look to-day at the map of Africa, what changes have been wrought upon it within the memory of men now living, within the last ten or fifteen years, mainly by the engineer! Only this month they have opened a new line of railway which connects Buluwayo in the interior with the Cape of Good Hope; and at Buluwayo, within the last two decades, there lived a monster who ruled over the district, in which, as some of you know, all sorts of atrocities were practiced. What has wrought the change? Simply the triumphs of the engineer in bringing into the heart of Africa the civilizing influences which, through lack of communication and intercommunication, had hitherto been excluded. Or look at India. When the Declaration of Independence came out, the British held only a few acres of ground for a trading fort. What has happened since? Why, at the present time, between three and four hundred million people there are subjects of Queen Victoria. That achievement is no doubt due to many causes. It is due to the political skill with which the English have used the natives to fight their battles; but it is due also to the invention of James Watt, who made it possible to connect the seacoast with the empire beyond the sea, and it is due also to the engineering skill by which roads and railroads have been run in and through every part of India. When Li Hung Chang visited us, some of you will remember that while he claimed for his own people that in philosophy and in works of reflection they equaled the profoundest philosophers that the world had yet produced, they were yet behind Europe and America, because they lacked what we have here and what you represent to-day—the science of engineering.

Nor are the achievements of your profession merely or perhaps primarily of a practical order. It is in the world of practice, of course, that we see the results. But, nevertheless, your profession ranks you with scholars, with the men who practice the learned vocations. It is only within the last generation that that has been recognized. But now in all our universities, the oldest as well as the newest, schools of engineering are established and the men who

graduate in them are placed on the same footing as the men who graduate in what used to be called the learned professional schools. If you take, for instance, the profession of law, there is not an institution in the United States which has so long a course for its graduates as many of them, and perhaps most of them, require from the civil engineer; and if only a few years ago men could walk from the streets, as it were, into the law schools, that has never been true of the schools of civil engineering, and the best of them to-day require of those who matriculate a knowledge of mathematics, which is equal to that formerly required, in the old-fashioned colleges, of the graduates in the B. A. course. We are coming to recognize throughout the country that engineering is a learned profession, and that the men who practice it need the same sort of scientific training and professional culture that is demanded of practitioners in law and in medicine. And the reason for this is perfectly clear. The engineer is applying the laws of Nature. Before you can have applied science you must have science to apply, and the works of the engineers rest on such fundamental sciences as mathematics, physics and chemistry, and no one can master these sciences in the thorough way which is now required for the solution of the great engineering problems of the age—no one, I say, can master them in a shorter time than that which is devoted to the study of law or to the study of medicine.

I am glad to think, Mr. President, that James Watt, whom I have already mentioned, although he lived over a hundred years ago, and before engineering schools had been established in any of our universities or in any universities in the world, was, nevertheless, associated with a university. On account of ill-health he was unable to complete his apprenticeship, and the guild to which he belonged refused to permit him to practice or to work in the City of Glasgow. But the college took care of him. They appointed him mathematical-instrument-maker, and it was while he held this subordinate position in the University of Glasgow that he began those studies on the Newcomen engine—which, as you know, was merely a steam pump—he began those studies, I say, which resulted in the production of the steam engine with a separate condenser. It is a satisfaction to me as a university man to recall that Watt, whom we may in some respects regard as the founder of engineering science, was in that way associated with the universities.

If I were asked what the desiderata of the engineering profession, as we see it at the present day, are, I should answer, first of all, you need, as all the learned professions need, to know more. Nature spreads out around us with infinite mystery. We have dipped in here and there and made shallow soundings; but the dimensions of attained knowledge, even if we take the knowledge of the race, are ludicrously small in comparison with the great ocean of mystery that stretches beyond. The ideal of the civil engineer—he may never attain it—but his ideal, if he is true to his profession, is so to master the laws of Nature that man may be able to control the powers of Nature and to make them serve his uses and minister to his needs. I often think that Shakespeare, universal genius as he was, defined, too, the ideal of your profession. In his ripest, and I suppose his latest play, "The Tempest," he has given us in Prospero the embodiment of the engineer, as also, Mr. President, the embodiment of the genius of true Christianity. Prospero is the man, you remember, who can forgive his enemies—forgive the brother who has ruined him and dethroned him, and pray for those who despitefully use him. But he is also the magician who can so wield all the powers of Nature that he has but to speak and the thing he wills is done. So long as there is crime or sin in the world there will be place for the preachers and the reformers and the prophets; and so long as you, gentlemen of this Association of Civil Engineers, fall short of that wonder-working ideal which is embodied in Prospero, will there be work and abundant work for you to do. May I venture to express the hope and the earnest wish that your housing in this commodious building may in some measure contribute to that high end.

ADDRESS OF HON. JOSEPH H. CHOATE.

Mr. President and Ladies and Gentlemen,—Unfortunately for you I have received no intimation to be brief. But my safety lies, and yours too, in my little knowledge of the subject in hand. It was a great philosopher who said "One thing I know—that I know nothing," and always afterwards he was regarded as one of the greatest and wisest of mankind. But I do feel very grateful for the opportunity that has been given me on behalf, as it was suggested by the Committee, of the other professions, of welcoming this youngest, most vigorous, and, I believe, most useful, of all the learned professions in this very critical and important day in its life. There is necessarily a fellowship and a very close fellowship among all the learned professions. We are all engaged alike in studying and applying laws to the uses and convenience of mankind, and in that respect the engineers, as it seems to me, have a very decided advantage over the other and older professions. They work from known and certain premises to inevitable conclusions. Theirs is an exact science, based not upon opinion, based not upon judgment, but upon absolute and fundamental facts in respect to which they ought not and cannot be allowed to err. But we of the other professions stand very differently. Ours are all uncertain—based upon opinion, upon experiment, upon judgment. When the doctor loses his patient, it is never his fault. He goes on, he lives on, and acquires new patients and new fame. When the lawyer loses his case, it is never his fault. He can always trace it to the infirmities of the law, or the weakness of the judge, or the dullness of the jury, or the evil conduct of his client. But it is not so with the engineer—the civil engineer; with him a blunder is indeed a crime. If his bridge falls, he falls with it. If his tunnel collapses, he collapses with it—and had better be buried in its ruins. Now, there is another respect in which, as I think, the profession of engineering has another very decided advantage over us. Our works perish. The breath of the lawyer is the measure of his fame. The rules, the practice and the law of the medical profession change from age to age, and—if the Bishop will allow me to say so—even the dogmas of theology are not forever unchangeable. But the works of the engineer live after him as an enduring monument to carry down to a distant posterity his merits and his defects.

In a little term of leisure last winter I wandered over the Island of Sicily, and on the heights of Euryalus overlooked what once had been the site of the City of Syracuse, which had absolutely disappeared so that not a vestige of it remained. The great fortifications that the predecessors of Archimedes had built under that lofty hill remained unchanged as they were built for military purposes more than two thousand years ago. At Girgenti and Pæstium we gazed upon temples still standing, in form perfect, as they were erected by engineers and builders whose names have been forgotten, still holding out models of beauty and grace for the imitation and instruction of mankind. At Rome we rode over the bridge of St. Angelo, more than a thousand years old. We stood under the dome of that matchless model of architecture, the Pantheon, as perfect apparently as when the name of its builder, Agrippa, was emblazoned upon its front. We stood before the ruins, the matchless ruins, the splendid ruins, of the Coliseum. All these great structures testify to a far-distant posterity of the power and the beauty that dwelt in the minds of their designers; and I have been wondering since I was invited to take part in these proceedings whether any works yet constructed by engineers or builders in this America of ours will last as long as those; whether the men of the thirtieth century, the students of architecture, of engineering, will find something yet to admire, even though it be in ruins, of the works of the men of the nineteenth and the twentieth centuries? That question I shall prefer to leave to these distinguished experts who are members of this American Society of Civil Engineers. But the truth nevertheless does remain that the work of these great engineers of to-day, the men who build our great bridges, our great docks, our great tunnels, our great railroads, will be carried down to a posterity that will long since have forgotten the doctor, the lawyer, and even the clergyman, who are now ruling over us.

I think it a very fortunate thing in respect to these days and events that the opening of this building for the use of the American Society of Civil Engineers is exactly coincident with the starting of this great metropolis in which we live and of which, in spite of its mistakes, we are all so proud, upon its new and greater career. Why, New York is only an infant to-day. She is just bursting her swaddling bands. She has outgrown herself and is really bursting her bands in all directions. You cannot venture into the streets without the peril of los-

ing your life as a sacrifice to the great engineering works that are going on to-day. And I am sure that that great province for engineering now extending over an area of 350 square miles—359 square miles is the exact quantity—holds out more work for the conscientious, the intelligent and the skilful engineer than all America did fifty years ago. What bridges are to be built over these noble rivers! What tunnels are to be excavated! What roads laid out! What docks constructed! Why, think of it; we have one project now pending before us, one work of tunneling and of bridging and of road building at an expenditure—the appalling expenditure—of 50 millions of dollars! Now, what I hope is that the new administration, which the people of this city in their wisdom have elected to preside, will come here—I hope they are here—I hope the Mayor-elect is here, to learn a lesson that no other place could teach as well as this; that the great engineering works of this city, which are to absorb millions upon millions of the people's money and occupy years and decades in their construction, shall be placed under the charge of competent engineers as the heads of the departments in which the public works belong. I think the science of engineering has advanced so far, and I hope the science of municipal government has advanced so far, that hereafter it will not be considered sufficient to have as Commissioner of Public Works either a lawyer or a politician who is as ignorant of engineering as the unfortunate person who now has the honor of addressing you.

This Society well calls itself the American Society of Civil Engineers because it is a truly national institution for the service of the whole nation, made up of educated engineers, engineers in every branch of civil engineering. Now, President Schurman has said something about its being a new profession, and General Craighill asserted that it was the oldest profession that he knew anything about. Well, that is only a difference of verbiage, of phraseology. It is true that fifty years ago there were not many civil engineers, and if they had been presented to an audience like this, the audience would have been quite at a loss to know what they were. But they have been training, and are being trained from the beginning. It is true the colleges did not do much for them. I remember when ex-President Morison, one of the most distinguished engineers of this country, and one of the most distinguished ex-Presidents of this Society, left Harvard College, he found it necessary to spend a year or two in my law office to lay the

foundations of that great engineering fame. And I am happy to say now that three successive Presidents of this Society, including the gentleman who presides here to-day, are graduates of Harvard College. I think it shows what we believe in the other professions, that for technical education there must first be laid as a foundation a broad, liberal education. But I was going to say what the engineers had done for the Nation. It is true they have not been the founders of the Nation; but they have been the makers and the builders of the Nation. Now, let us see exactly how that is in a very few words. When this Nation was founded, for I look upon the making and adoption of the Federal Constitution in 1787 as the founding of the Nation, there had been no engineering and no engineers in America except the military gentlemen whom Washington had summoned to his aid for the conduct of the war. There was no bridge over any navigable river in what now constitutes the United States; no harbor but presented its natural appearance as it had been from the beginning of time. Of course, no railroads, no tunnels, no roads worthy of the name, of any description. Why, then, it took the Members of Congress who went in their own carriages from Boston to Philadelphia six days to make the journey, and they had to cross in ferries the mouths of six navigable rivers. Two hundred years had been spent by the settlers in grappling with the wilderness, and in desperate struggling. What had been accomplished? Fifty miles in breadth along the Atlantic coast, from Maine to Georgia, was all that then represented the triumphs of those two centuries. Well, then the Federal Constitution was adopted. You remember that memorable scene on the day when Hamilton wrote the names of the States on the last page of the document, at the foot of the document, and Washington and Franklin and all the rest of them subscribed their names. Franklin, looking at the painted sun that was behind the chair of Washington, who presided in the convention, said: "All through these debates I have been wondering whether that was a rising or a setting sun. Now that these names have been signed to that immortal document, I am sure that it is a rising sun." But if Washington and Franklin, the two wisest members of all that wise gathering, could have foreseen that within a hundred years the area of the United States—in which the constitution which they then formed was to carry the blessings of liberty to a distant posterity—was to extend not simply

from the Atlantic to the Mississippi, but three times as far—from the Atlantic to the Pacific, and from the Gulf to the Lakes, and that in the ordinary administration of executive power it might be necessary for the President to issue an order, for the very salvation of the Republic, that should be obeyed within one hour on the Pacific coast—if they had contemplated that it might be necessary to transport in three days three hundred thousand men from the Lakes to the relief of the beleaguered capital—even they would have trembled at the sublime audacity of the experiment that they were undertaking. Why Franklin himself, with all his power, with all his learning—he had snatched the lightning from the clouds and the sceptre from tyrants; he knew all about steam that anybody knew; he was the matchless master of electricity up to that date, and yet even he had no conception of the means and appliances by which this nation was after all to be made one. Let me read you what he said only the year after the convention adopted the Constitution and adjourned. In writing to a friend of his, in the month of October, 1788, from Philadelphia, he says:

"We have no philosophical news here at present, except that a large boat rotated by the force of steam is now exercised upon our river, stems the current and seems to promise being useful when the machinery can be more simplified and the expense reduced."

And Mr. Madison in the *Federalist*, in arguing very laboriously the possibility of the Federal Government exercising efficient control over our vast territory as it then extended from the Atlantic to the Mississippi and from Maine to Georgia, says:

"The difficulties will indeed be great, but as the nation will extend no further than the Mississippi and no further south than Georgia, it will be quite practicable for the delegation from those distant regions to reach the seat of government in time to take part in the deliberations of Congress."

And now what do you see? What has been done since then; all done by these engineers? As Mr. Seward said at the outbreak of the War of the Rebellion: "No parchments, no laws, will hold this nation together; but bridges and railroads and steam and the telegraph, they will and must do it."

Now, I will not detain you, for you all know what these engineers have done. The highway from the Atlantic to the Pacific was the very saving of our Pacific seaboard, the Rocky Mountain States, to the

Union. You all know perfectly well what immense works, both public and private, have been constructed by them in every quarter of the Union; how peace and plenty, and order and law, and art and civilization have followed in their track; how they have made commerce so fruitful, the people so flourishing and happy and have brought with them to stay prosperity throughout the land.

Now, when I received this invitation I thought I would like to know something about some engineers, and I got one of the most entertaining books or set of books that I for one have ever read. As there are some here who are not engineers, I advise them to get it and read it, and that is Smiles' "Lives of the British Engineers." They are more fascinating, each one of them, than anything that can be found in the Arabian Nights—more bewitching in their fortune, their character and their achievements. They all seem to tell one story. They had no colleges, they had no universities where they could study the elements of their profession. They were almost uniformly sons of laborers, born in laborers' cottages, nurtured under hardships, apprenticed to a youth of hard labor, manifesting always indomitable courage, vast power of labor, a perfect passion for construction, and patience that knew no end, and courage that equaled anything that any warrior ever exhibited, and conscience always—it is one of the most honest and conscientious professions that has yet come into the world. They stumbled upon their first works apparently almost by accident. They showed themselves worthy by the perfection of the work they did, the conscientiousness with which they did it, and they went on from one piece of work to another, ever greater and grander and grander; and when they were called to their last home they were followed to the grave, not by humble cottagers who had surrounded them at birth, but by kings and nobles and the intelligence, the brains, the culture and the wisdom of the realm. Where did they end their careers? Just where they should; among the greatest benefactors of mankind, in Westminster Abbey. Doubtless all of you remember that splendid statue of Watt, to whom President Schurman has already referred, by Chantry, on which is inscribed an epitaph prepared by Lord Brougham which he counted the greatest honor of his life to have been permitted to write; and then, too, you find as you walk through the nave the graves of Thomas Telford and of Robert Stephenson—two more of the great benefactors of the human race—the one the "Colossus of Roads,"

as his friend Southey delighted to call him; the other the perfecter of the locomotive. He and his greater father—if I may be permitted to call him so—George Stephenson, had worked together in the development of that vast machine upon which now the prosperity of the human race itself depends.

Now, how did they do all this? How did these great engineers achieve these marvelous triumphs? Well, I think it was only—to borrow a phrase of Emerson's—by hitching their wagon to a star, and if you will permit me to read a few words from Emerson in conclusion, which I think he intended for just such an occasion as this, and in writing which I believe he had in mind the American Society of Civil Engineers and all civil engineers in general, you will understand what I mean when I say—recalling Lord Bacon's phrase, that every man owes a debt to his profession—that the debt these civil engineers owe is to follow in the footsteps of those great men whom they all unite in honoring and revering; and now, if you will allow me to read this short passage from Mr. Emerson, I will take my seat. He says:

"Now, that is the wisdom of a man, in every instance of his labor, to hitch his wagon to a star and see his chore done by the gods themselves. That is the way we are strong, by borrowing the might of the elements. The forces of steam, gravity, galvanism, light, magnets, wind, fire, serve us day by day and cost us nothing. Hitch your wagon to a star. Let us not fag in paltry works which serve our pot and bag alone. Let us not lie and steal. No god will help. We shall find all their teams going the other way—Charles' Wain, Great Bear, Orion, Leo, Hercules: every god will leave us. Work rather for those interests which the divinities honor and promote—justice, love, freedom, knowledge, utility. If we can thus ride in Olympian chariots by putting our works in the path of the celestial circuits, we can harness also evil agents, the powers of darkness, and force them to serve, against their will, the ends of wisdom and of virtue."

RESOLUTIONS ADOPTED.

During the meeting the President read the following dispatch from the Institution of Civil Engineers:

"Congratulations to the American Society on opening their New House."

George S. Morison, Past President, Am. Soc. C. E,, then spoke as follows:

Mr. President, I believe that all the members of the Society who are present are very glad to hear our profession spoken of in the way in which it has been mentioned. It is right, however, for us to recognize that though we consider ourselves a great profession, our greatness must be in the future rather than in the past, and that we are just being welcomed into the ranks as the youngest brother among the older professions. I think, therefore, that it is right that we should do something in appreciation of what has been done for us to-day, and I would therefore offer the following brief resolutions:

"*Resolved*, That this Society tenders its thanks to the representatives of the university, of the law and of the clergy who have so kindly joined us in the dedication of our new home.

"*Resolved*, That this Society has received with great satisfaction the congratulations of the oldest and greatest engineering institution that the world has ever known, and hopes that the warm fraternal relations of older and younger brethren may always continue between the two organizations."

I offer these resolutions.

The resolutions were adopted.

MEMOIRS OF DECEASED MEMBERS.

THEODORE DEHONE JUDAH, M. Am. Soc. C. E.*

DIED NOVEMBER 2D, 1863.

Theodore Dehone Judah, to whom the first transcontinental railway in this country owes in a large measure its incorporation and early success, came from a family which settled at Westport, Conn., in the early days of the colony. His father was an Episcopal clergyman, and it was while he was rector of St. John's Church in Bridgeport, Conn., that the subject of this memoir was born, the date being March 4th, 1828. Soon afterward the family moved to Troy, N. Y., where the father was called to be the rector of St. John's Church, and the son received his early education in that city, studying at the Rensselaer Polytechnic Institute at one time. The father died before the son's studies were completed, however, and the family moved to New York City.

By this time the young man was convinced that his talents destined him for the profession of engineering, and he soon joined the staff of S. W. Hall, then engineer of the Troy and Schenectady Railroad Company, and began his railroad career. Afterward he served under James Laurie, first President of this Society, and was engaged on the New Haven, Hartford and Springfield Railway and the Connecticut River Railroad. Another work of his in New England, which he referred to with pride, was the construction of a railroad bridge at Vergennes in Vermont. Subsequently he was a resident engineer on the Erie Canal, located at Jordan and Seneca Falls, and afterward was engineer of the railroad down the gorge of the Niagara River to Lewiston, a work which was considered a remarkable feat in those days, and resulted in his engagement as engineer of the first California railroad. He was employed on the construction of the Buffalo and New York Railroad, then pushing across the state to connect with the Erie line, when he received a telegram from Governor Seymour, who was acquainted with the Niagara line and the difficulties presented by its construction, to go to New York at once. There he met Colonel Charles L. Wilson, who was enthusiastic over the proposed railroad between Sacramento and Folsom, and immediately accepted the posi-

* Memoir prepared from information furnished by Mrs. R. A. Pierce, C. P. Huntington, F. Am. Soc. C. E., and from a lecture entitled, "Theodore D. Judah, the Engineer of the Central Pacific Railroad," delivered at Stanford University by Mr. Theodore H. Hittell.

tion of chief engineer of the enterprise. In a short time he and his wife were on their way to the Pacific Coast, and from then until his untimely death, his work assumes a character of great commercial importance. In a brief biography of her husband, Mrs. Judah states, "that everything he did from the time he went to California to the day of his death was for the great continental Pacific railway. It was the burden of his thought day and night and largely of his conversation."

It was as the chief engineer of the Central Pacific Railroad that Judah achieved his greatest reputation, not only as an engineer, but also as a promoter, using the word in its best sense. He was identified with California railroading from its beginning. The State Legislature passed a general law for the organization of railroad companies in 1850, and after it was amended several times, active preparation for work on a road was begun in 1853 by the Sacramento Valley Railroad Company. The most important step taken was the engagement of Judah as the engineer of the enterprise, in the manner mentioned. Immediately after reaching California he selected a route from Sacramento to Folsom, a distance of 32 miles. Grading was commenced early in 1855, and tracklaying in the summer, as soon as rails arrived. The road was opened in February, 1856, but did not prove as profitable as was anticipated. It was purchased nine years later by the principal owners of the Central Pacific Railroad Company.

A large part of Judah's time during the next three years was spent in Washington endeavoring to procure the passage of a bill making grants of land in California for railroad purposes. Congress was not disposed at that time to take any definite action on the subject of a transcontinental railroad, then attracting considerable attention on the Pacific coast, so a railroad convention was held at Sacramento in September, 1859, to consider the matter. Each county in California, Oregon, Washington and Arizona was requested to send as many delegates as it had members in the state or territorial legislatures. The attendance was large. Among the delegates certainly the best posted and probably the most efficient was Judah, who was present as a member from Sacramento. He had studied the engineering problems of a transcontinental road and was thoroughly convinced of the practicability of such a project. It was chiefly due to the fullness, clearness and satisfactory character of the information he furnished that the convention declared its decided preference among the routes mentioned for the central one advocated by him, and appointed him to act as its accredited agent in presenting its proceedings to the President, Cabinet and Congress, and in promoting favorable action on a Pacific railroad bill.

The Washington mission was unsuccessful, owing to the sectional jealousy so strong at that time. Mr. Judah wrote out a full report of his work, which he sent to the executive committee of the convention

with many important documents. An unusual part of the report was a statement that although the expenses of his mission had cost him $2 500, the only bills he had to present were two small accounts for printing, amounting together to $40. In spite of the temporary failure of this congressional campaign, he returned to California with unabated confidence in the project and endeavored to arouse greater local support for a continuance of the agitation. His first attempt to raise funds was made in San Francisco, but in spite of the fact that some of the capitalists to whom he presented his plans recognized their importance, the local business field offered such inducements of large and immediate returns that they did not care to back an enterprise bound to require great expenditures before any profit could be realized. Undismayed by his failure at San Francisco, Judah went to Sacramento, where he was sure of the influence of General Lauren Upson, editor of the Sacramento *Union*.

Among his fellow townsmen of Sacramento were four merchants, Collis P. Huntington, F. Am. Soc. C. E., and Mark Hopkins, who were hardware dealers; Charles Crocker, who was in the dry goods business, and Leland Stanford, who dealt in provisions and groceries. The first two had been in California since 1849; none of them was rich. These four men with Judah formed a quintette in which the deficiencies of any one member were remedied by the characteristics of the others. It was through their assistance and under the personal direction of Judah that the different routes over the Sierra Nevada Mountains were examined and compared.

The Central Pacific Railroad Company was organized on June 28th, 1861, under the laws of California, with a capital stock of $8 500 000 in $100 shares. C. P. Huntington, Leland Stanford, Mark Hopkins and Charles Crocker made liberal subscriptions to the stock, and a number of other citizens of Sacramento subscribed for smaller amounts. Judah organized his engineering parties again and crossed the mountains more than twenty times before making his final location. He confined his attention chiefly to three routes; the first through El Dorado County by way of Georgetown, the second through Illinoistown and Dutch Flat, and the third by the way of Nevada and Henness Pass. The Dutch Flat route proved the most practicable, as by it he could attain the summit at Donner Pass with lighter grades, at less distance, and with fewer obstacles than by any other line.

The problem presented was to ascend 7 000 ft., the height of Donner Pass, in a distance of not much more than 70 miles. After careful examination a long and unbroken spur of the Sierra Nevadas was found extending southwesterly from Donner Pass to the Sacramento Valley. By keeping on or near the ridge of this spur, the summit could be attained with a maximum grade not exceeding 105 ft. to the mile along a route crossing but one stream, and that a small one. On the other

hand, the eastern slope of the Sierras could be descended as far as the Truckee River by means of two ravines south of Lake Donner, with a maximum grade of 140 ft. per mile. Judah's route followed the Truckee from a point near the outlet of Lake Donner, and about 14 miles north of Lake Tahoe, through the eastern ridge and Washoe Mountains to Big Bend in the Humboldt Desert, giving a grade not exceeding 40 ft. to the mile and entirely avoiding the second or eastern ridge of mountains. The distance from Sacramento to the Truckee was 123 miles by this route, and 145 miles to the State line. Judah estimated that eighteen tunnels would be necessary, and that the road could be kept free from snow throughout the year. The probable cost of the road was given as about $88 500 per mile for the entire 145 miles to the State boundary.

As soon as his report was made he was sent to Washington to procure aid for the construction of the road. He became acquainted with members of the committees on the Pacific Railroad in both branches of Congress and was appointed Secretary of both, with the privilege of the floor in both Senate and House. Although the opposition previously offered by southern Congressmen was wanting in this session by reason of the civil war, there were many obstacles to be overcome and much tactful manœuvering and compromise necessary before the desired legislation was obtained on July 1st, 1862. The act contained references to three companies. It incorporated the Union Pacific Railroad Company for constructing a part of the transcontinental route, provided for the construction of another part by the Leavenworth, Pawnee and Western Railroad Company of Kansas, and gave to the Central Pacific Railroad Company the recognition and privileges it had been struggling so hard to obtain. It was provided that the company might construct a railroad and telegraph line from the Pacific Coast, at or near San Francisco, or the navigable waters of the Sacramento River, to the eastern boundary of California. Right of way for 200 ft on each side of the road was granted, and all ground needed for buildings and five alternate sections of public land, per mile, on each side of the line, or all the odd sections within the limits of 10 miles on each side which had not been sold, reserved or otherwise disposed of, except mineral lands. In consideration of the mountainous character of the country for 150 miles west from the eastern base of the Rocky Mountains, and for 150 miles east from the western base of the Sierra Nevada Mountains, the Secretary of the Treasury was instructed to issue to the company constructing these sections bonds to the amount of $48 000 per mile; the bonds to be issued and the lands granted set apart on the completion of every 20 miles of these portions of the road. The amount of bonds to be issued for the intermediate country between the Sierra Nevada and the Rocky Mountains was fixed at $32 000 per mile, and $16 000 for the remaining sections. The company had to

build 50 miles in the first two years and 50 miles each additional year, half the amount of construction required of the Union Pacific Company.

Judah lost no time in filing in the office of the Secretary of the Interior the necessary maps and papers relating to the route of the Central Pacific Railroad, thereby securing the withdrawal from sale of land along the line. He made arrangements in New York for rails and other equipment for the first 50 miles of road, and late in July sailed for San Francisco, carrying with him a testimonial from a number of senators and representatives as to the value and effectiveness of his work.

The first shovelful of earth taken on the work of construction was moved at Sacramento by Leland Stanford on January 8th, 1863, the day following his inauguration as Governor of California. In spite of the national assistance granted during the preceding summer, work progressed slowly and capital was enlisted with difficulty. By this time the leading men in the enterprise had found the work best suited for each. Huntington became the eastern financial manager, and Stanford the western, Crocker devoted himself to superintending the construction, Hopkins looked after the supplies, and Judah superintended the engineering work. Six months later, Judah filed a report estimating the cost of the first 50 miles of the road at nearly $3 250 000; at this time, the bridge over the American River was nearly completed and about 18 miles graded. Six thousand tons of rails had been purchased, six locomotives and about fifty cars.

In October of the same year, he sailed from San Francisco to urge further legislation by Congress for the transcontinental railroads, and to affect certain changes in the company. The latter are best indicated by the following quotation from Mrs. Judah's memoir of the husband.

"Mr. Judah saw he must place himself differently, and he went to work to accomplish it. He had secured the right and had the power to buy out the men opposed to him and the true interests of the Pacific Railroad at that time. Everything was arranged for a meeting in New York City on his arrival. Gentlemen from New York and Boston were ready to take their places. They could not see him. Two of the gentlemen came to see me in Greenfield, thinking I might be able to give them points for their interest."

He was attacked by fever on the journey, and died on November 2d, 1863, at New York. His work was carried on by the parties before mentioned, who had furnished financial backing to the enterprise, until it has expanded into one of the most powerful railway systems of the world. Judah was, in a measure, its founder and most influential advocate, and it was largely through his manifold talents, apart from engineering, that a transcontinental railway was recognized as of national importance by Congress.

Mr. Judah was elected a Member of the American Society of Civil Engineers on May 4th, 1853.

ISAIAH WILLIAM PENN LEWIS, M. Am. Soc. C. E.*

DIED OCTOBER 18TH, 1856.

Isaiah William Penn Lewis was born in Charlestown (now Boston), Mass., July 15th, 1808. He was the son of Captain Isaiah Lewis and Harriet Ann Townsend Lewis, née Cox. He received his education in Boston, but owing to his father's death during his own boyhood he did not attempt to pursue professional life. He followed the sea for several years, which had been his father's occupation, and was in command of vessels trading to the East, to the Gulf of Mexico and elsewhere. Before he was thirty years of age he gave up maritime life and studied civil engineering in Boston and commenced business for himself in that city about 1840. In 1843–44 he made a visit to France and there made himself thoroughly familiar with the Fresnel system of lighthouse illumination, and on his return to this country undertook to secure its adoption by the United States Government, in which object, after long and arduous effort, he was finally successful.

From 1845 until the time of his death in 1856, he was almost constantly in government employment, engaged in visiting and reporting on the various lighthouses along our coast and in introducing the new system gradually. He superintended the construction of the lighthouse at Sand Key, Key West, Fla.; somewhat later, that at Galveston, Tex., and probably others. In connection with this employment he made several visits to England and the Continent, making extended examinations of lighthouse construction and operation, especially in the former country, and was in communication with various prominent scientific men, particularly with James Nasmyth, the eminent engineer and inventor.

Mr. Lewis married Miss Ellen Augusta Doane, in Boston, October 29th, 1840. Notwithstanding his extended absence, he retained his citizenship in that place until his death, October 18th, 1856. He left no children.

Mr. Lewis's aptitude for mechanical construction may be fairly said to be hereditary. His grandfather, Lemuel Cox, was probably the most skilful bridge-builder of his day. He constructed, in 1786, the deep water bridge connecting Boston and Charlestown, after it had been repeatedly pronounced impracticable, owing to the rapidity, as well as the depth, of the tidewater, and subsequently built bridges at Malden and Salem, Mass. The Charlestown bridge was the first to connect Boston with the surrounding main land. His success in these works led to his being invited to Ireland in 1789 to erect the bridge over the Foyle at Londonderry, which he completed in less than the

* Memoir prepared by F. W. D. Holbrook, M. Am. Soc. C. E., and Joseph Willard, Esq.

contract time, a remarkable compliment to his skill, coming as it did from the mother country to an American, and so soon after the Revolution. He was then employed to construct bridges at Wexford, Waterford, Ross Craig and elsewhere, and was engaged in these various enterprises nearly ten years before he returned to America.

Personally, Mr. Lewis was a man of very attractive manner, with exquisite taste and great skill in drawing, in painting in water-colors, and in music, and he made a wide circle of friends.

Mr. Lewis was elected a Member of the American Society of Civil Engineers on January 5th, 1853.

EDWARD SOUTHWICK PHILBRICK, M. Am. Soc. C. E.*

DIED FEBRUARY 13TH, 1889.

Edward Southwick Philbrick was born at Boston, Mass., November 20th, 1827, and was always identified with that city, although his residence was in Brookline for most of his life. His education was received in the local public schools and at Harvard College, where, however, he did not follow the regular course and never graduated. About twenty-five years later, however, the college granted him the degree which he had been prevented from obtaining in the regular manner.

Railroad engineering in New York and Vermont engaged his attention for a few years, but becoming interested in structural engineering, he relinquished his position to spend a year and a half abroad, part of the time studying at Paris, but most of the time in travel. Returning in 1855, he was for some time assistant superintendent and engineer of the Boston and Worcester Railroad.

Mr. Philbrick inherited strong anti-slavery convictions from his father, and after the outbreak of the Civil War was active in the work of the Sanitary Commission. When Port Royal was taken and great numbers of negroes entered the Union lines, Mr. Philbrick was among the volunteers who went to that place to assist in educating the ex-slaves. There he remained until the close of the war, actively engaged in the work undertaken by the Freedmen's Societies which was of such aid during those trying times.

When the war was over he returned to Boston and became consulting engineer of the Boston and Albany Railroad, a position he held for a number of years. He had charge of the design and construction of many iron bridges on this road, of the large Union Station at Worcester, and of grain elevators in Boston. His observations and studies

* Memoir prepared from information furnished by George F. Swain, M. Am. Soc. C. E., and papers on file at the House of the Society.

in Europe, where he had made a careful investigation of the methods of bridge construction, led him to become a strong advocate of riveted connections, and such details were employed exclusively on the bridges of the Boston and Albany road which were built under his direction. His practice with this company gradually led to his being consulted by other railway corporations, and he was recognized as an expert in matters pertaining to bridge work. Among his engagements was one by the State of Massachusetts as consulting engineer on the Hoosac Tunnel, and another as engineer of the improvement of the South Boston Flats.

Sanitary engineering was a favorite study with Mr. Philbrick. His architectural experience gave him an insight into the principles of plumbing and house drainage, and his knowledge of matters pertaining to sewerage and water supply led to frequent engagements by town and city authorities. He was among the earliest American engineers to insist on the importance of good plumbing and to urge the adoption of scientific methods in designing and carrying out such work. For a number of years he was a member of the Board of Selectmen and the Water Board of Brookline, and rendered particularly valuable service to the town in connection with the system of water-works built during this time.

Technical education had a strong advocate in Mr. Philbrick, and for many years he was a member of the corporation of the Massachusetts Institute of Technology, in which school he was accustomed to deliver a number of lectures annually.

Mr. Philbrick was elected a Member of the American Society of Civil Engineers on September 6th, 1874, and contributed two papers to *Transactions*. The first was published in Volume VII, and is entitled "The Improvement of the South Boston Flats;" the second was published in Volume XVII, and is entitled "Inspection and Maintenance of Railway Structures." He also took part in the discussion of several papers.

During the latter part of his life he was engaged in several business enterprises, and found little time for engineering work, although he continued to lecture before the students of the Massachusetts Institute of Technology.

For many years previous to his death he was a frequent contributor to the *Engineering Record*, and some of his articles in that paper were published in a book bearing the title "American Sanitary Engineering." A memoir of him in that journal closes as follows:

"Those who knew him but slightly may have been somewhat repelled by a certain brusqueness of manner, which at first seemed to imply some want of consideration for the feelings of others; but only those who knew him well can fully appreciate the kindly heart, the depth and tenderness of friendship, and the philanthropic spirit—manifested in many ways—which lay beneath the surface. Only such will fully realize their loss."

ISAAC WILLIAMS SMITH, M. Am. Soc. C. E.*

DIED JANUARY 1ST, 1897.

A notable figure was removed from among the engineers of the Pacific Coast by the death of Isaac Williams Smith, which occurred at Portland, Ore., January 1st, 1897.

He was born at Fredericksburg, Va., in 1826, the son of Rev. George A. Smith and Ophelia Ann Williams, the latter a granddaughter of Captain Philip Slaughter, an officer of the Revolution.

He was educated at the Fairfax Institute at Clairens and at the Virginia Military Institute at Lexington, Va., graduating from the latter with high honors in 1846, at the age of twenty.

After graduation he served for a time as assistant engineer under Captain Emory, U. S. A., on the survey of the northeast boundary. Later, receiving an appointment as second lieutenant in Company K, United States Voltigeurs, he served in the detachment under Major Lally in the war with Mexico during one campaign, and was then detailed for recruiting service and stationed at Baltimore. In 1849–50 he was assistant engineer and astronomer on the survey of the parallel between the Creek and Cherokee Indians under Lieutenants Sitgreaves and Woodruff, U. S. A. In 1851 he was assistant astronomer and first assistant on the survey of the parallel between Iowa and Minnesota, Andrew Talcott being chief engineer. In 1852 he was resident engineer on the survey and construction of the Orange and Alexandria Railroad under Chief Engineer Atkinson. In 1853–54 he was assistant engineer upon the Pacific Railroad surveys and explorations along the southern route under Lieutenants Williamson and Parke, of the Corps of Engineers, U. S. A. After a brief sojourn in California, he came north to the newly formed territory of Washington, and was engaged as engineer and special agent for the construction of lighthouses on the Straits of Fuca and Shoalwater Bay, the Twelfth Lighthouse District, under Major Hartman Bache, Corps of Engineers, U. S. A. These guides for mariners were erected at New Dungeness, Tatoosh Island and Smith's Island, on the Straits of Fuca, and at Tokes Point, on the coast of southwestern Washington. This work was accomplished with considerable difficulty and peril, journeys to and from the works being made either in small rowboats or Indian canoes through waters that were of a very treacherous character, and often with only Indians for his crew.

The uprising of the Indians against the whites all over the northern

* Memoir prepared by D. D. Clarke, M. Am. Soc. C. E., Edward G. Tilton, C. E., and Robert P. Maynard, C. E.

country, commonly called the Yakima War, occurred during the years 1855–56, and many settlers lost their lives. An armed force was quickly raised, and in the campaign that followed Mr. Smith served as aide-de-camp on the staff of Captain I. I. Stevens, then Governor of the Territory, and in command of the volunteer forces engaged in subduing the Indians, and saw much active service. After the close of the war he was engaged for a year or two as United States Deputy Surveyor under his life-long friend, Major James Tilton, also a veteran of the Mexican War, and then filling an appointment as United States Surveyor-General for Washington Territory, and surveyed several of the meridian and standard parallel lines then being established through the trackless and all but impassable forests of western Washington. Completing this work, he was appointed Register of the United States Land Office for the Olympia District, which included the then vast Territory of Washington.

In 1862 he joined the rush that came from every point on the Pacific Coast to the newly discovered placers in Cariboo, B. C., where he remained but a short time. On his return from the mines, he went east to his native state and tendered his services to the Confederate government. Receiving the appointment of captain of engineers, later being brevetted colonel, he was continuously employed until the close of the war upon the defences before Petersburg and Richmond. After the surrender at Appomattox, he returned home, the possessor solely, as described in his own words, "of an old gray uniform, much tattered and worn, a good horse, and a large amount of experience." He soon found employment in the operating department of one of the dilapidated Virginia railroads, but in a few months, in 1866, received an appointment as division engineer on the Imperial Mexican Railroad from Vera Cruz to Mexico under Andrew Talcott, chief engineer, and was placed in charge of the line from Paso-del-Macho to Ongaba. He remained in Mexico during the years 1867–68, engaged upon this work and as chief engineer and inspector of drainage and hydraulic work near Tepic for Messrs. Barron & Forbes.

In 1869 he was again on the Pacific Coast serving as engineer on construction of the Western Pacific Railroad, later merged into the Central Pacific, and as superintendent of repairs, etc., from Sacramento to San Francisco, under S. S. Montague, chief engineer.

In 1870 he entered the service of the Northern Pacific Railroad Company under Edward A. Flint, engineer of the Pacific Division and W. Milnor Roberts, chief engineer, and was placed in charge of surveys along the Columbia and Cowlitz Rivers in Washington Territory. After a few months of service with the Northern Pacific he was entrusted with the design and construction of locks and a canal around the falls of the Willamette River, a few miles above Portland, Ore., a work of considerable magnitude, and of great im-

portance in giving free river navigation from the Willamette valley to the ocean.

The contractors not having proceeded with satisfactory diligence, at the end of a year the work was taken out of their hands and carried forward by Colonel Smith with great rapidity. Early completion was of vital importance to his company, as upon that depended a very large state subsidy which would have lapsed had the works not been completed at a certain fixed date, then drawing very near. The Colonel accomplished the desired end in time, and not only secured the large subsidy for his company, but turned over a work of which the excellence of design and thoroughness of execution marked its engineer as a man of notable skill and ability.

During the year 1873 but little engineering work was in progress in the Northwest, and Colonel Smith spent a good portion of the time superintending the execution of large land survey contracts awarded by the United States Surveyor General for Washington Territory. In December of that year he was called again to the service of the Northern Pacific Railroad Company, and placed in charge of the survey of the new terminal, city of Tacoma, the location for which had been determined upon a few months before. In the latter part of 1874 he made an examination of the Fraser River in British Columbia, from Soda Creek to Lytton, reporting upon the feasibility of rendering the same navigable by the removal of gravel bars and rocky barriers. In February, 1875, he visited Peru at the invitation of Colonel Edward A. Flint, who hoped to secure for him a responsible position in connection with one of the trans-Andean railways then building.

Upon his arrival finding the country again in the throes of civil war, and all railway construction interrupted, he returned at once to California, and, entering the service of the Southern Pacific Railroad Company, was detailed to make surveys for that road in Arizona.

A year later, in association with Colonel George H. Mendell of the Corps of Engineers, U. S. A., he made an exhaustive study and report upon the water supply for the city of San Francisco. As Colonel Mendell's chief assistant he had charge of the extensive surveys which were made, including all the available sources of supply.

From April, 1876, to April, 1878, Colonel Smith was one of the Board of Railroad Commissioners for the State of California, the other commissioners being Mr. John T. Doyle and General George Stoneman. In May, 1878, he was appointed chief engineer of the Sacramento River Drainage District Commission which had under consideration a project for a drainage canal to carry off flood waters along the west side of the valley opposite Sacramento, from Knight's Landing to Suisun Bay, a distance of 46 miles.

The issuance of bonds to a large amount for this undertaking depended upon the favorable report of the chief engineer. The surveys

and examinations showing the project to be impracticable, the report of the engineer was decidedly adverse, and the scheme was abandoned.

From this time until the spring of 1880, Colonel Smith was chief engineer for the Board of State Harbor Commissioners of California, in which capacity he designed the sea wall for the water front of the city of San Francisco, and constructed upwards of a mile of it, together with its appurtenant wharves.

In April, 1880, he was again called to the service of the Northern Pacific Railroad Company, then about to undertake extended surveys of the Cascade Range, north of the Columbia in Washington, for the purpose of deciding upon the location of its line to Puget Sound, and was placed in full charge of the Cascade Mountain surveys. This work he prosecuted with great vigor, employing a large corps summer and winter, and before the end of the next year, 1881, the several routes across the mountains had been thoroughly examined. The route finally adopted, *via* Stampede Pass, was one of the new lines surveyed and mapped under his direction.

In September, 1881, he was appointed to the position of chief engineer of the Oregon Pacific Railroad Company, then engaged in constructing a line eastward from Yaquina Bay, Ore. He remained with this company two years, completing the line as far as Corvallis, about 60 miles, and then resigned and returned to Tacoma, Wash., where he made an examination and report upon the water supply for that city. During the years 1883 to 1885, he was chief engineer for the Tacoma Light and Water Company, designing and constructing the gas and water plants for Tacoma at an expense of nearly half a million dollars, and superintending the works for some months after completion. During this period he also made surveys and designed a system of improvements for the water front of Tacoma Harbor, for the Tacoma Land Company.

For many years the city of Portland, Ore., was furnished with water by a private corporation which pumped its supply from the Willamette River. The quality of the water not being satisfactory, the State legislature authorized the city to construct works of its own and placed the entire control of the water system in the hands of a water committee composed of well-known and substantial citizens. Early in the year 1886 this committee called Colonel Smith to its aid and placed in his hands the work of determining the future water supply for the city. After exhaustive surveys he reported in favor of a gravity supply from Bull Run River at a point in the foot hills of the Cascade Range about 30 miles east of the city. The cost of bringing in as large a supply as desired being greater than expected, the construction of the proposed system was not at that time deemed expedient, and the existing system was purchased and Colonel Smith placed in charge as engineer and superintendent, which position he

continued to hold until his death. Plans and specifications for the new gravity supply were prepared, and legislative authority having been secured for the issuance of bonds to obtain funds to carry them out, construction of the new system was begun in March, 1893, and completed January 1st, 1895, at an outlay of nearly $3 000 000.

This, his *magnum opus*, was the last of a long series of beneficent works he had constructed for the comfort, health and safety of mankind, and he was, happily, permitted to live to see it completed and in successful operation for two years before his death.

For several years his leisure hours were spent in the preparation of a treatise on the "Theory of Deflections and of Latitudes and Departures, with Special Application to Curvilinear Surveys and Alignments of Railway Tracks," which he published, and only a few months before his death he prepared a paper on the "Flow of Water in Wrought and Cast-Iron Pipes from 28 to 42 Ins. Diameter," for publication in the *Transactions* of this Society.*

He became a Member of the American Society of Civil Engineers on October 1st, 1873.

The foregoing is but a brief epitome of some of the occupations of a long and active life. Colonel Smith's reputation as an engineer of ability and integrity became established early, and his services were continually in demand. That all of the many positions of responsibility which he occupied were faithfully and acceptably filled none can dispute, as many monuments of his versatile genius amply testify. Those who came to know him intimately found a man in whom they could trust, always desirous of dealing justly with all men, and of doing that which was right for the sake of right and because it was in accord with the Divine command. Of commanding presence, he won the love and esteem of a large circle of friends and left an impress for good upon all with whom he came in contact. Although of a domestic disposition, the subject of our sketch never married.

The following, from the pen of one who was associated with Colonel Smith at various times, will meet with a sympathetic response in the hearts of all those who ever knew him.

"During the various periods when I was associated with Colonel Smith I had the opportunity of seeing him under many and varied circumstances. I can truly say that there was nothing in my whole acquaintance with him but what tended to increase my admiration and respect for the man. He was one of the few engineers whom I have ever been associated with who combined a thorough theoretical knowledge of mathematical principles with a practical grasp of the best methods for the solution of the various problems that were being constantly presented to him in the conduct of his work.

* See Vol. xxxvi, p. 197.

"The Colonel was not only a fine mathematician, but his acquaintance with, and pleasure in, the best classes of literature made him always a most charming and instructive companion. Reading seemed to be the kind of rest and relaxation he most enjoyed.

"There is one trait which characterized the Colonel to a marked degree, and that is his absolute integrity and incorruptibility Another trait of his character was his thorough self-forgetting unsel fishness. He was not only a devoted son and brother, but in his intercourse with the men in his employ he was always thinking of their comfort and welfare rather than his own. Certainly, in all my experience I do not know of another man who could equal the Colonel in his rare combination of strength and purity and gentleness of character. There is one character in fiction of whom the Colonel very often reminded me. I refer to Thackeray's character of Colonel Newcome.

"I shall always feel that it has been one of the privileges of my life to have known as intimately as I did a man of the character of Colonel Smith."

FRANCIS ASBURY LYTE, Assoc. M. Am. Soc. C. E.*

DIED JUNE 24TH, 1896.

Francis Asbury Lyte was born in East Lampeter township, Lancaster County, Pa., on March 6th, 1854. His education was obtained in the public schools of the township, and at the Pennsylvania Normal School at Millersville. For about two years after graduating he taught school at Ebensburg, Pa. His engineering career did not commence, so far as can be learned, until 1881, when he was engaged as chainman for the Pittsburg, McKeesport and Youghiogheny Railroad. He rose rapidly through the grades of rodman, instrumentman and assistant engineer to that of first assistant engineer. From March, 1882, to September, 1883, he was in charge of a transit party for Baker & Gilmore of Minneapolis, Minn.; in September, 1883, he was associated with F. L. Straw in the purchase of the good-will of his employers, and for somewhat over a year carried on a general surveying practice in city and railroad work. The firm was dissolved in 1885, and Mr. Lyte acted for a year as the general western agent of the Morse Bridge Company. In 1888 he was chief engineer of the Kane Oil Field Railroad. From June, 1889, to June, 1891, he was general eastern agent for the Variety Iron Works Company, and afterward represented the Massillon Bridge Company in the East.

When the First National Bank at Kane, Pa., was organized, early in 1896, Mr. Lyte was unanimously chosen cashier, and he held this position until his death, which occurred on June 24th, 1896.

* Memoir prepared from information furnished by Dr. E. Oram Lyte, and from papers on file at the Society House.